International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.482

(03/2021)

SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Digital transmission of television signals - Part 4

Requirements of a radio frequency (RF)/Internet protocol (IP) video switching system

Recommendation ITU-T J.482

Recommendation ITU-T J.482

Requirements of a radio frequency (RF)/Internet protocol (I/IP) video switching system

Summary

Recommendation ITU-T J.482 defines the requirements of a radio frequency (RF)/Internet protocol (I/IP) video switching system.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T J.482	2021-03-01	9	11.1002/1000/14602

Keywords

Audience rating, headend (HE), internet protocol (IP), network bandwidth, radio frequency (RF), set-top box (STB), switching.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents/software copyrights, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the appropriate ITU-T databases available via the ITU-T website at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Introduction

This Recommendation represents Part 1 of a multi-part deliverable covering the requirements for a radio frequency (RF)/Internet protocol (IP) switching system, as identified below:

– **Part 1: Requirements;**

– Part 2: Architecture and functional specifications.

Cable television operators provide subscribers with a variety of video services composed of RF-signal-based video (RF-video) and IP-signal-based video (IP-video), e.g., linear and non-linear video on demand (VOD) over cable networks where the bandwidth is finite. Presently, in 2021, cable operators are facing the problem of how to meet the 4K RF/IP video demands of subscribers when faced with the difficulties of extending the network bandwidth due to network costs.

In general, with an RF-video distribution scheme, the received video quality is stable since the video is distributed and received at a fixed coding bitrate over a quality-guaranteed network where a fixed transmission bandwidth is reserved for each video. Utilization efficiency of cable networks is, however, low since the transmission bandwidths are occupied by the videos regardless of audience ratings.

In contrast with the IP-video distribution scheme, the received video quality is unstable since the video is distributed and received at a variable or adaptive coding bitrate over a best-effort network where a transmission bandwidth is not reserved for each video. Utilization efficiency of cable networks is, however, high since the transmission bandwidths are used for not only video but also Internet data according to subscribers' requests.

For the response to the current situation, a highly efficient cable transmission scheme that takes the advantages of both RF-video and IP-video distributions has been studied in order to maintain the received video quality and to improve the utilization efficiency of cable networks. The point is to share the RF and IP network bandwidth and to switch the distribution scheme adaptively between RF and IP according to the video content audience ratings, available network bandwidths, and attribute (e.g., emergency degree) of video content on the cable headend (HE) side. On the receiver side, either RF-video or IP-video signals are received in turn, but seamlessly form an uninterrupted video stream.

Recommendation ITU-T J.482

Requirements of a radio frequency (RF)/Internet protocol (I/IP) video switching system

1 Scope

This Recommendation defines the Requirements of RF/IP switching system over cable network.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T J.122] Recommendation ITU-T J.122 (2007), *Second-generation transmission systems for interactive cable television services – IP cable modems.*

[ITU-T J.222.0] Recommendation ITU-T J.222.0 (2007), *Third-generation transmission systems for* interactive *cable television services – IP cable modems: Overview.*

[ITU-T J.222.1] Recommendation ITU-T J.222.1 (2007), *Third-generation transmission systems for* interactive *cable television services – IP cable modems: Physical layer specification.*

[ITU-T J.222.2] Recommendation ITU-T J.222.2 (2007), *Third-generation transmission systems for interactive cable television services – IP cable modems: MAC and Upper Layer protocols.*

[ITU-T J.222.3] Recommendation ITU-T J.222.3 (2007), *Third-generation transmission systems for* interactive *cable television services – IP cable modems: Security services.*

[ITU-T J.224] Recommendation ITU-T J.224 (2020), *Fifth-generation transmission systems for interactive cable television services – IP cable modems.*

[ITU-T J.225] Recommendation ITU-T J.225 (2020), *Fourth-generation transmission systems for interactive* cable *television services – IP cable modems.*

[ITU-T J.297] Recommendation ITU-T J.297 (2016), *Requirements and functional specification of cable set top box for 4K ultra high definition television.*

[IEC 62481] IEC 62481 (All parts), *Digital living network alliance (DLNA) home networked device interoperability guidelines*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 4K video: A video that supports 3 840 × 2 160 resolution and ~60p frame frequency.

3.2.2 audience rating: An index that shows what percentage of video content provided by the cable operator is being watched by subscribers.

3.2.3 HD video: A video that supports 1 280 × 720 / 1 920 × 1 080 resolutions and ~60p frame frequency.

3.2.4 SD video: A video that supports 720 × 480 resolution and ~60p frame frequency.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Program Interface
CAS	Conditional Access System
CM	Cable Modem
DLNA	Digital Living Network Alliance
DOCSIS	Data Over Cable Service Interface Specifications
DRM	Digital Rights Management
FEC	Forward Error Correction
HD	High Definition
HDCP	High-bandwidth Digital Content Protection system
HDMI	High-Definition Multimedia Interface
HE	Headend
IPTV	Internet Protocol Television
IP	Internet Protocol
ONU	Optical Network Unit
PON	Passive Optical Network
PSI	Programme Specific Information
QAM	Quadrature Amplitude Modulation
RCU	Remote Control Unit
RF	Radio Frequency
SD	Standard Definition Television
SI	Service Information
STB	Set-Top Box
UHDTV	Ultra-High Definition Television
UI	User Interface
VOD	Video On Demand

5 Conventions

In this Recommendation:

The keywords "**is required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "**is recommended**" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "**is prohibited from**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "**can optionally**" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

In the body of this Recommendation and its annexes, the words *shall*, *shall not*, *should*, and *may* sometimes appear, in which case they are to be interpreted, respectively, as *is required to*, *is prohibited from*, *is recommended*, and *can optionally*. The appearance of such phrases or keywords in an appendix or in material explicitly marked as *informative* are to be interpreted as having no normative intent.

6 Overview

6.1 The concept of RF/IP switching system

The purpose of RF/IP switching is to create an environment where almost all the subscribers can watch 4K videos. To realize this, there are two points as follows: The first point is the sharing of RF and IP network resources. The second point is to control and switch the video qualities and distribution scheme for each video content adaptively, according to the following three parameters: attribute of video content (e.g., emergency degree), available network bandwidth, and audience rating of content. Figure 1 shows the priority rule by which video resolution and bitrate is controlled according to audience ratings and emergency degrees. By preferentially distributing video channels with a high audience rating in 4K resolution and high bitrate, it is possible to realize an environment in which almost all subscribers can watch 4K channels. The reason why an RF distribution scheme is higher priority than an IP distribution scheme is that the RF distribution scheme is more stable than that of the IP described as an introduction.

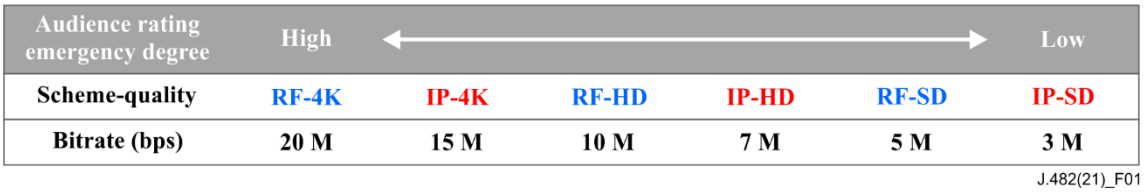

Figure 1 – Priority rule of controlling video qualities and distribution schemes

Figure 2 shows the proposed RF/IP switching system. The basic principle is as follows:

1. The optimizer collects the audience ratings, available network bandwidth, and attribute of video content from STBs, network probes in the access network, and content providers, respectively in real-time.
2. The optimizer calculates the optimal allocation of the distribution scheme and video quality for each video content by maximizing the switching indicator score which is derived from video content bitrate (resolution), audience rating, network bandwidth, and video content attribute.
3. The optimizer sends a switching order and the allocation to the switcher for each video content.
4. The switcher changes the video distribution scheme including video quality for each video content according to the switching order and the allocation from the optimizer.

Note that by using this scheme, video signal can avoid quality degradation due to IP network congestion even though the IP network itself is unmanaged.

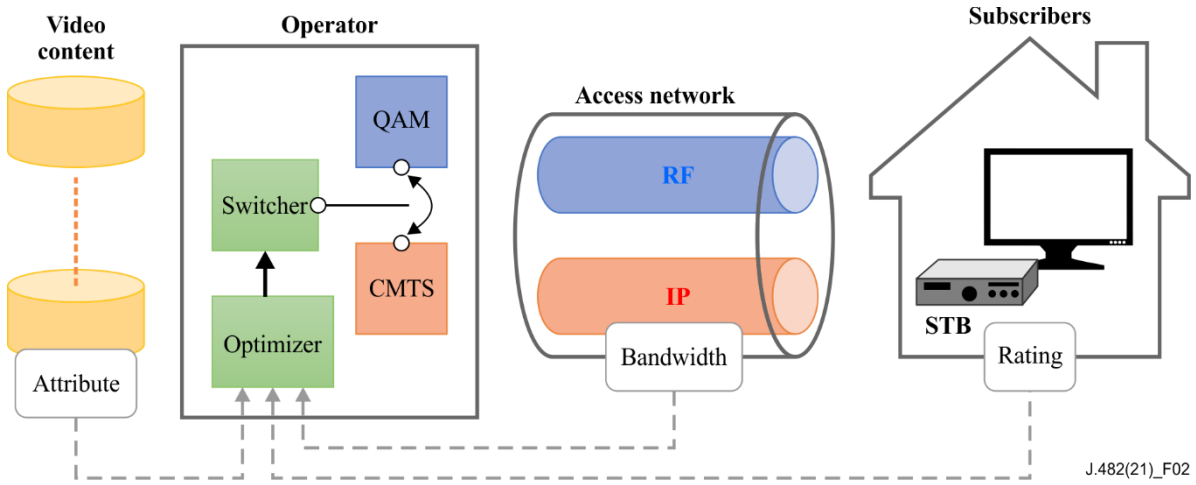

Figure 2 – RF/IP switching system

6.2 The fundamental system architecture of RF/IP switching scheme

A fundamental system architecture including the key components is shown in Figure 3. The requirements of these key components are described in the following section.

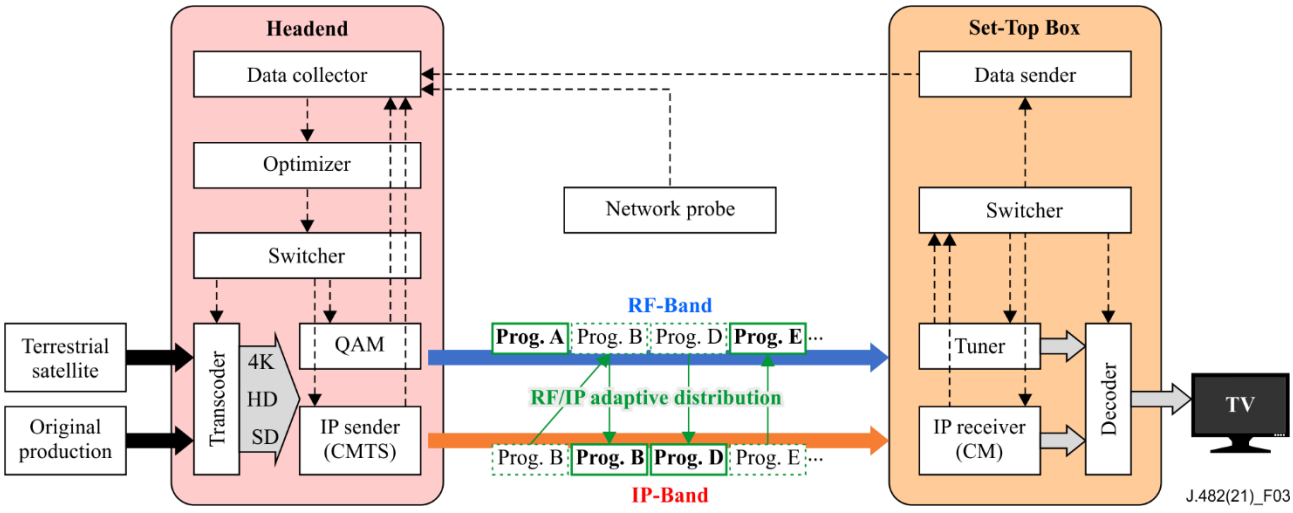

Figure 3 – A fundamental RF/IP switching system architecture

7 Requirements

An RF/IP switching system works with the interaction of a headend (HE) and STB. This clause describes the requirements of an RF/IP switching system from two aspects: 1. system requirements; 2. STB requirements.

7.1 System requirements

RFIPSW-SystemReq-01: The system is required to distribute 4K/HD/SD video content via RF signals (QAM modulation).

RFIPSW-SystemReq-02: The system is required to distribute 4K/HD/SD video content via IP signals (DOCSIS (2.0 [ITU-T J.122], 3.0 [ITU-T J.222.0 to J.222.3], 3.1 [ITU-T J.225] or 4.0 [ITU-T J.224]) or PON scheme).

RFIPSW-SystemReq-03: The system is required to collect information regarding audience ratings, network bandwidth and video content attribute from STBs, network probes in the access network and the content provider, respectively in real time.

RFIPSW-SystemReq-04: The system is required to equip an algorithm for switching the video distribution scheme and video quality of each video content. The algorithm is required to optimize allocation of the distribution scheme and video quality for each video content by maximizing the switching indicator score, which is derived from the video content bitrate (resolution), audience rating, network bandwidth and video content attribute from STBs, network probes in the access network and content providers, respectively in real time.

RFIPSW-SystemReq-05: The system is required to record the history of switching indicator scores and retain the most recent allocation of the distribution scheme including video quality for each video content.

RFIPSW-SystemReq-06: The system is required to compare the actual switching indicator score and ideal switching indicator score.

NOTE – The former is derived from the latest and optimized allocation and the current audience rating while the latter is derived from the retained allocation and the current audience rating.

RFIPSW-SystemReq-07: The system is required to switch the distribution scheme and video quality according to the derived switching indicator and allocation.

RFIPSW-SystemReq-08: The system is required to equip a function of real-time transcoding of the video content according to the derived switching indicator and allocation.

RFIPSW-SystemReq-**09:** The system is required to switch the video quality between 4K/HD/SD and to switch the video distribution scheme between RF and IP signals.

RFIPSW-SystemReq-10: The system is required to produce and include the switching trigger into the SI to be sent to the HE.

RFIPSW-SystemReq-11: The system is required to equip a function of probing the network bandwidth.

7.2 STB requirements

RFIPSW-STBReq-01 to RFIPSW-STBReq-15 are based on the requirements of a cable set-top box for 4K ultra-high definition television (UHDTV) [ITU-T J.297].

RFIPSW-STBReq-01: The STB is required to receive 4K/HD/SD video content broadcast by the cable HE.

RFIPSW-STBReq-02: The STB is required to equip a function of tuner that selects broadcasting channels.

RFIPSW-STBReq-03: The STB is required to equip a function of receiving RF signals (QAM de-modulation).

RFIPSW-STBReq-04: The STB is required to equip a conditional access system (CAS) decoding (de-scrambling) function used for content protection.

RFIPSW-STBReq-05: The STB is required to equip a de-multiplexing function for video, audio and service information (SI/PSI).

RFIPSW-STBReq-06: The STB is required to equip a function of receiving IP signals (DOCSIS (DOCSIS (2.0 [ITU-T J.122], 3.0 [ITU-T J.222.0 to J.222.3], 3.1 [ITU-T J.225] or 4.0 [ITU-T J.224]) or PON scheme).

RFIPSW-STBReq-07: The STB is required to equip a DRM decoding (de-scramble) function used for content protection.

RFIPSW-STBReq-08: The STB is recommended to equip a function of buffering the IP packet enough to compensate delay and jitter over IP transmission.

RFIPSW-STBReq-09: The STB is recommended to support a function for forward error correction (FEC) over IP transmission.

RFIPSW-STBReq-10: The STB is required to equip a function of decoding 4K/HD/SD video.

RFIPSW-STBReq-11: The STB is required to equip decoding advanced audio of 5.1 channels.

RFIPSW-STBReq-12: The STB is required to equip an output interface (such as HDMI 2.0) which supports 4K video.

RFIPSW-STBReq-13: The STB is required to support a user interface (UI) for TV channel selection operated with a remote control unit (RCU).

RFIPSW-STBReq-14: The STB is recommended to equip a function of software download.

RFIPSW-STBReq-15: The STB is recommended to support a remote management function.

The following are the requirements specific for RF/IP switching system.

RFIPSW-STBReq-16: The STB is required to switch the video content receiving and decoding scheme between the RF-signal pass or IP-signal pass according to the trigger included in the SI from the HE.

RFIPSW-STBReq-17: The STB is required to send the status of receiving and decoding processes from the RF tuner, CM or ONU, and the decoder to the switcher.

RFIPSW-STBReq-18: The STB is required to equip a function of sending periodically viewing data to the HE or the external audience rating calculating server.

RFIPSW-STBReq-19: The STB is required avoid switching interruption when using DLNA [IEC 62481] or recoding processes.

RFIPSW-STBReq-20: The STB is recommended to equip a function of super resolution and frame rate conversion for decoded images to maintain continuous video before and after switching.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	**Cable networks and transmission of television, sound programme and other multimedia signals**
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2021